ELEC 567: Nano-Optics

Instructor:
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Course Type: Lecture

Credits: 3

Meeting Times: Tuesdays and Thursdays 9.25 am - 10:40 am, Location HBH423

Office Hours: Wednesdays 2-3 pm, and by appointment

Objective

The goal of this course is to understand concepts of light localization and light-matter interactions on the nanoscale, and to familiarize the students with state-of-the-art research in the field of nano-optics. This will be done through a combination of in-class lectures, a hands-on lab project, and a final course presentation.

Course Description:

Nanophotonics is an emerging field that relates to the study and control of optical fields on length scales shorter than the wavelength of radiation. The goal of this course is to understand concepts of light localization and light-matter interactions on the nanoscale. We will introduce the theoretical framework of angular spectrum representation of optical fields to understand fundamental issues such as evanescent fields, strong focusing, and point spread functions. We will then cover a selection of topics of current interest in nano-optics like single molecule spectroscopy, near-field optical microscopy, optical antennas, photonic metamaterials, 2D semiconductor optoelectronics, and nanooptomechanics.

Student Learning Outcomes:

By the end of this course, students will be able to answer the following questions:

1. How tightly can light be focused, both in free space and close to a material?
2. How do elementary dipoles radiate in a nanoscale environment?

They will also be able to critically read research papers and communicate their findings to their peers.

Course Outline:

Week 1.	Tue 8/21	Introduction
	Thu 8/23	Focusing and Localization of Fields
Week 2.	Tue 8/28	Angular Spectrum Representation
	Thu 8/30	Point Spread Function; Resolution Limits
Week 3.	Tue 9/4	Confocal and Localization microscopies
	Thu 9/6	Nearfield Microscopy
Week 4.	Tue 9/11	Dipole Radiation and Green Functions (I)
	Thu 9/13	Dipole Radiation and Green Functions (II)
Week 5.	Tue 9/18	Single Quantum Emitters
	Thu 9/20	Energy Transfer; Weak and Strong Coupling
Week 6.	Tue 9/25	First and Second Order Optical Coherence
	Thu 9/27	Hanbury Brown Twiss Interferometry
Week 7.	Tue 10/2	Surface Plasmons
	Thu 10/4	Optical Antennas

Week 8.	**Tue 10/9**	**Midterm Recess (NO CLASS)**
	Thu 10/11	**Lab Project NO CLASS)**
Week 9.	**Tue 10/14**	**Lab Project NO CLASS**
	Thu 10/17	**Lab Project NO CLASS**
Week 10.	Tue 10/23	Electron-plasmon interactions
	Thu 10/25	2D Optoelectronics (1)
Week 11.	Tue 10/30	2D Optoelectronics (2)
	Thu 11/1	2D Optical Chirality
Week 12.	Tue 11/6	Optical Forces (1)
Week 13.	Thu 11/8	Optical Forces (2)
Week 14.	Tue 11/13	Cavity Optomechanics (1)
	Thu 11/15	Cavity Optomechanics (2)
Week 15.	Tue 11/20	Lab Project Oral Examinations
	Thu 11/22	**Thanksgiving NO CLASS**
Week 16.	**Tue 11/27**	***Course Presentations I***
	Thu 11/29	***Course Presentations II***

Textbook and Electronic Resources

I shall be following **Principles of Nano-Optics (2nd Edition)** by Lukas Novotny and Bert Hecht (Cambridge 2012) for about 70% of the course. Electronic versions of the unedited chapters from the first edition of this book (2006) can be found at the link below. Note that this is copyrighted material, and is **not to be distributed any further.**
https://www.photonics.ethz.ch/en/our-range/education/courses/nanooptics.html

Grading

Homeworks	**40%**
Lab Project	**30%**
Course Presentation	**30%**

An important component of the course is the hands-on lab component. Students will form groups of 2-3 and perform a laboratory experiment related to the course. Each group writes a 2-page report

For the final course presentation, each student will make a 30-minute presentation on a nanophotonics topic of his/her own choice. The final presentation dates **will not** be rescheduled, and you **must be present** on all presentation days to receive any credit for this component.

Honor Code Policy

For the homeworks, you may refer to any textbook or other online resources. You may discuss concepts and problem solving strategies with others. However, anything you turn in **must be your own work**. You may **not** copy solutions, either in whole or part, from another student.

Students with Disability

If you have a documented disability that may affect academic performance, you should (a) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111, adarice@rice.edu, x5841) to determine the accommodations you need, and (b) meet with me to discuss your specific accommodations.